PROPOSED INFRASTRUCTURE

Surface Water Projects Design Criteria

Surface water ASR projects like Project 1 - Ten Mile Canal, Project 1 typically require the following facilities:

- Horizontal well to provide in-bank filtration,
- Pump stations,
- pH adjustment, and
- Pre- and post- ASR well disinfection.

A typical process flow schematic for these facilities is shown on Figure 39. This figure conceptually presents the horizontal well, which will be constructed near the surface water source. From this point, the pH is adjusted with CO_2 prior to disinfection and injection into the ASR well. Water recovered from the well will then be disinfected before it is sent to the irrigation system.

Figure 40 illustrates how the horizontal wells and injection pumping are located in relation to one another.

Figure 41 presents how the injection well pump station will be configured. A minimum of two pumps will be used at each pump station. Piping size depends on each project's capacity requirement. This figure also shows the anticipated locations of power pole connections, meters, valves, and sample taps.

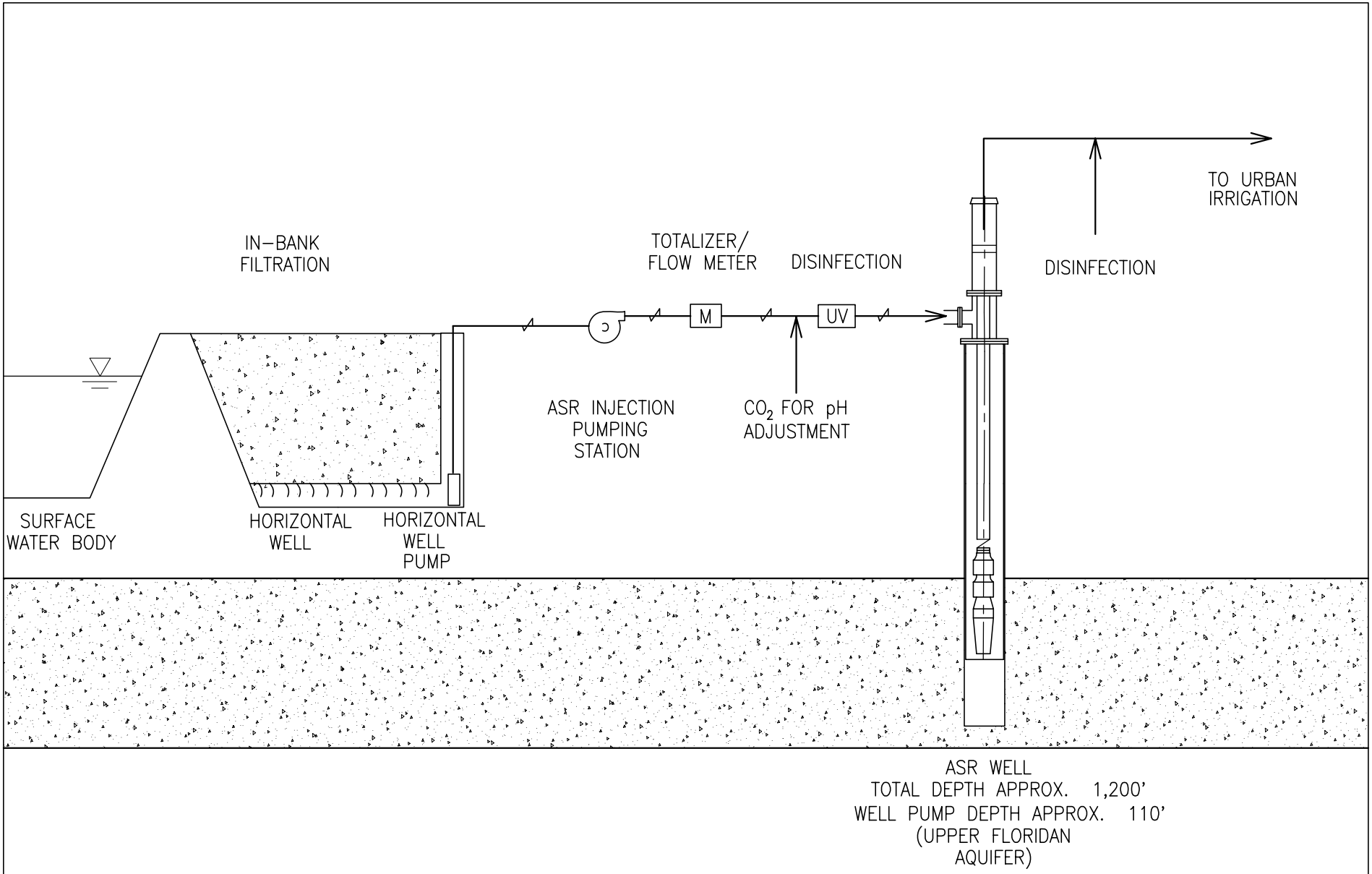
Figure 42 presents the layout of a typical ASR well. Figures 43 and 44 show horizontal well installation methods. The specific method used will depend on subsurface conditions at each project location.

Reclaimed Water Projects Design Criteria

The typical facilities for the reclaimed water ASR projects are similar to the surface water ASR projects, except for the horizontal well and the need for additional disinfection facilities (if the WWTP meets AWT limits). The reclaimed water will be treated effluent from the wastewater treatment plant, which will be injected into the ASR well. Prior to injection, the pH will be adjusted with CO_2 and then disinfected. This system is presented in Figure 45**.**

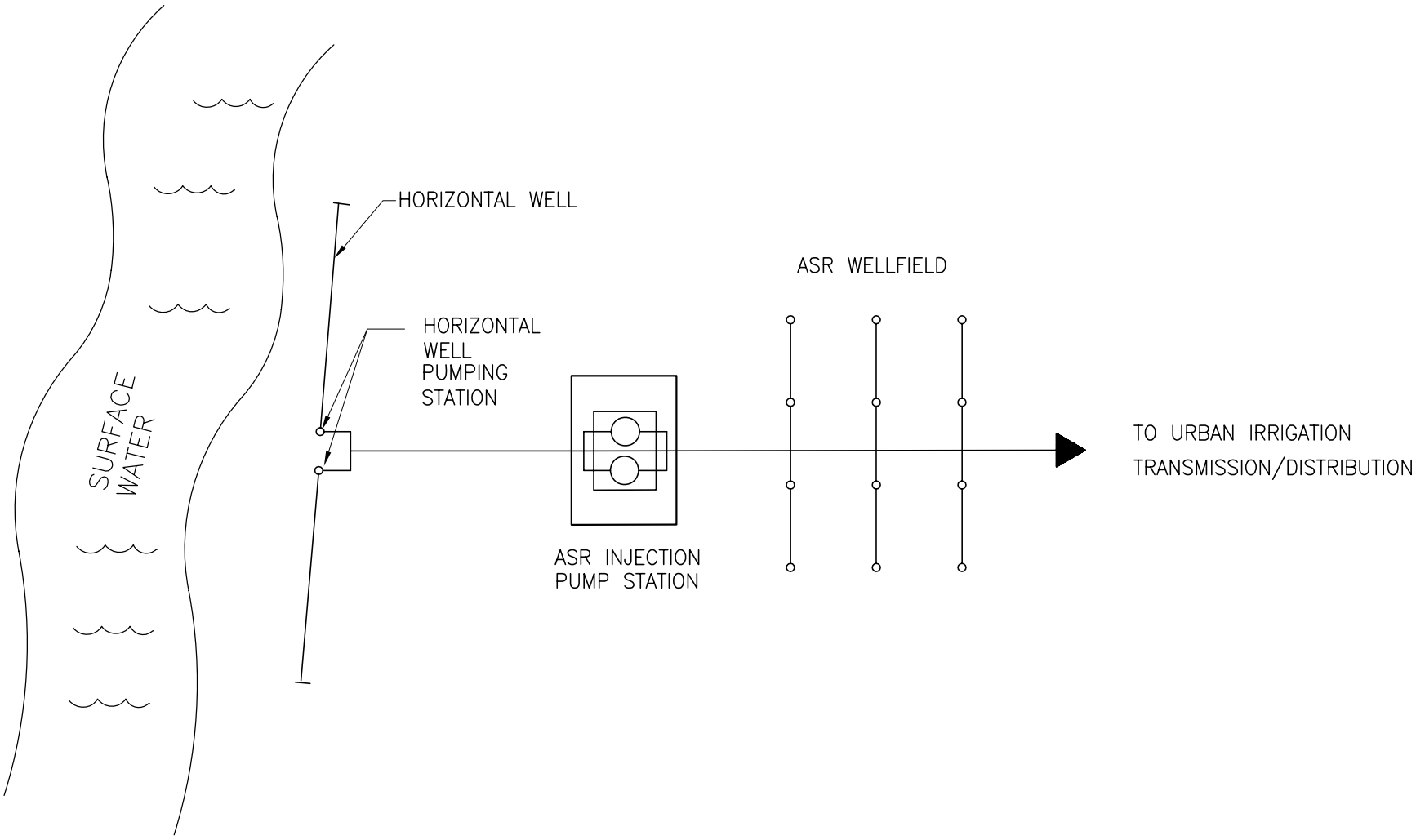
Interconnects

Interconnects can supply supplemental irrigation needs through resources available in either side of the connection. The proposed interconnect project between the City of Bonita Springs and Lee County is shown on Figure 38.

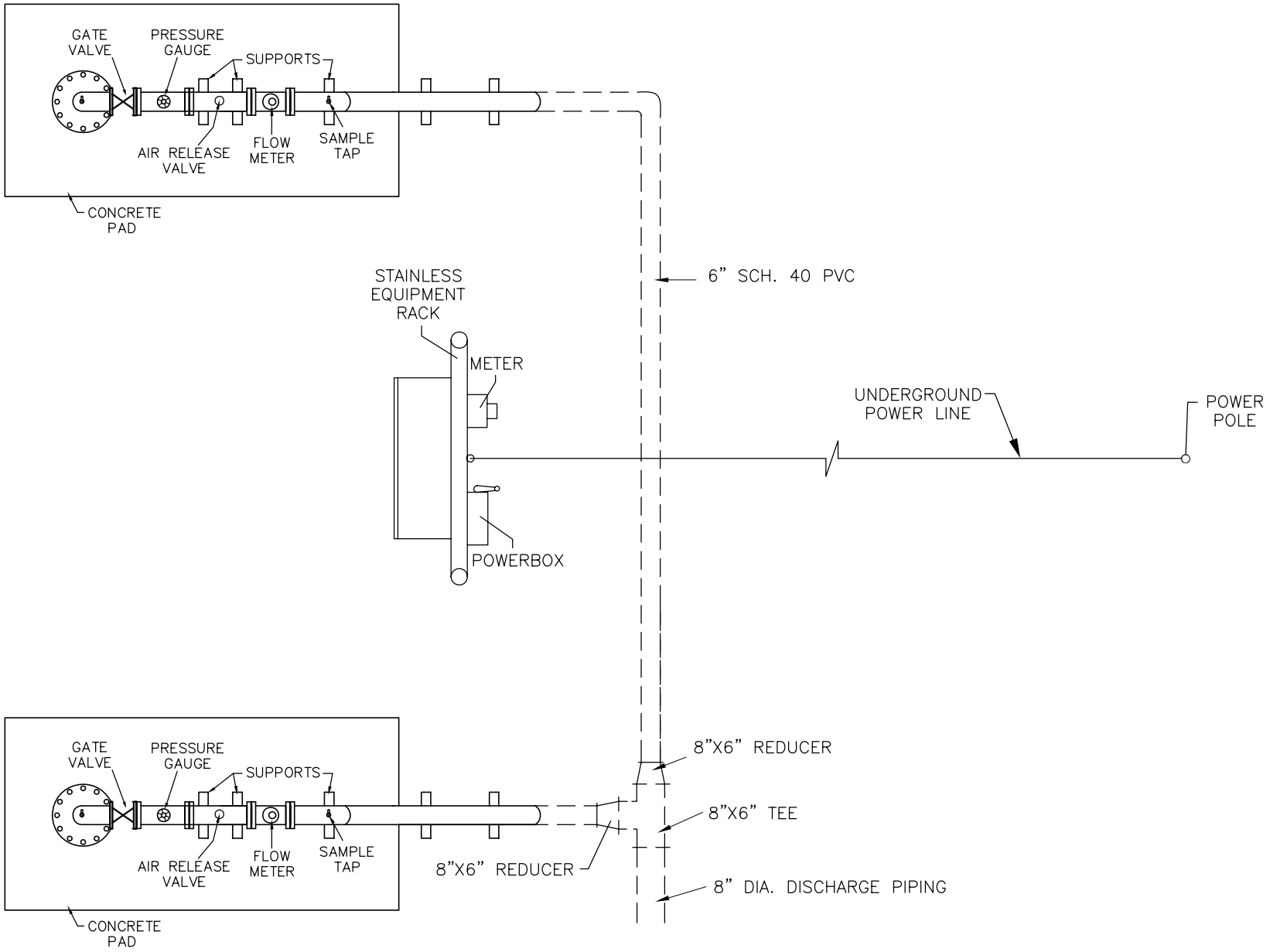


Not to Scale
For Conceptual Purposes Only

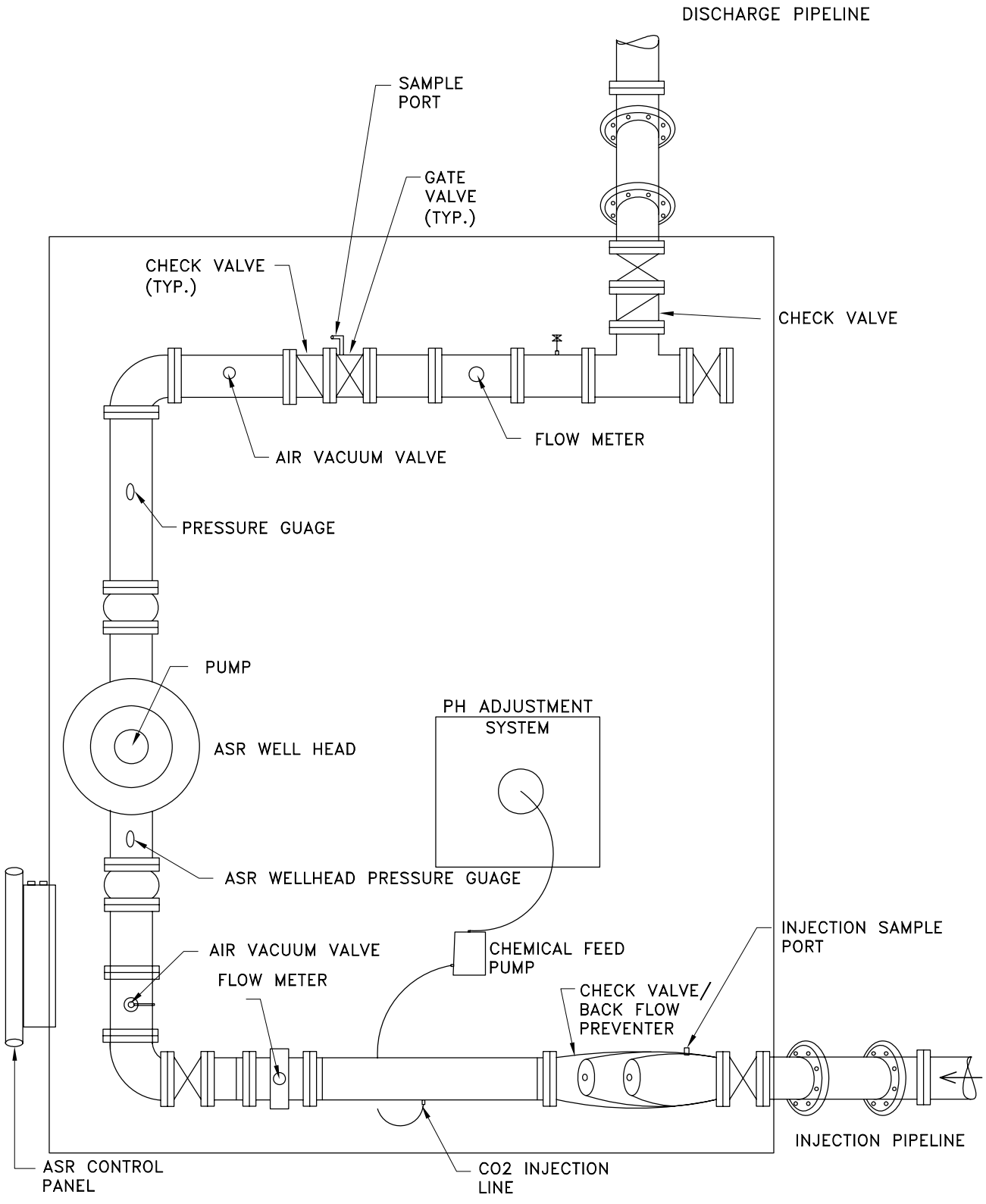
Regional Irrigation Distribution System (RIDS) Feasibility Study	BOYLE	South Florida Water Management District	Typical Surface Water ASR System Process Flow Schematic	Figure 39



Regional Irrigation Distribution System (RIDS) Feasibility Study	BOYLE		South Florida Water Management District	Typical Surface Water ASR System Layout	Figure 40



Regional Irrigation Distribution System (RIDS) Feasibility Study	BOYLE		South Florida Water Management District	Typical Horizontal Well Withdrawal Pumping Station	Figure 41



ASR WELL

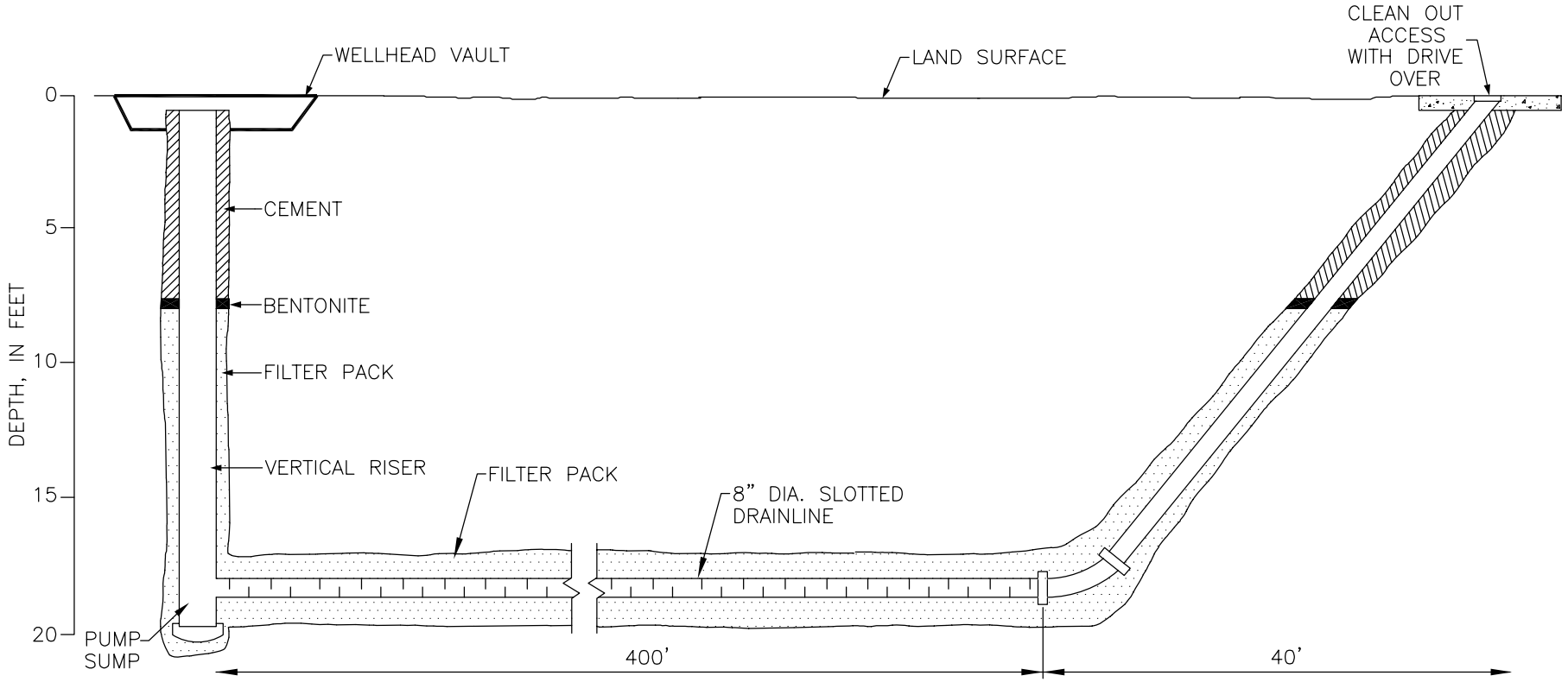
Figure 42

Typical ASR Well Layout

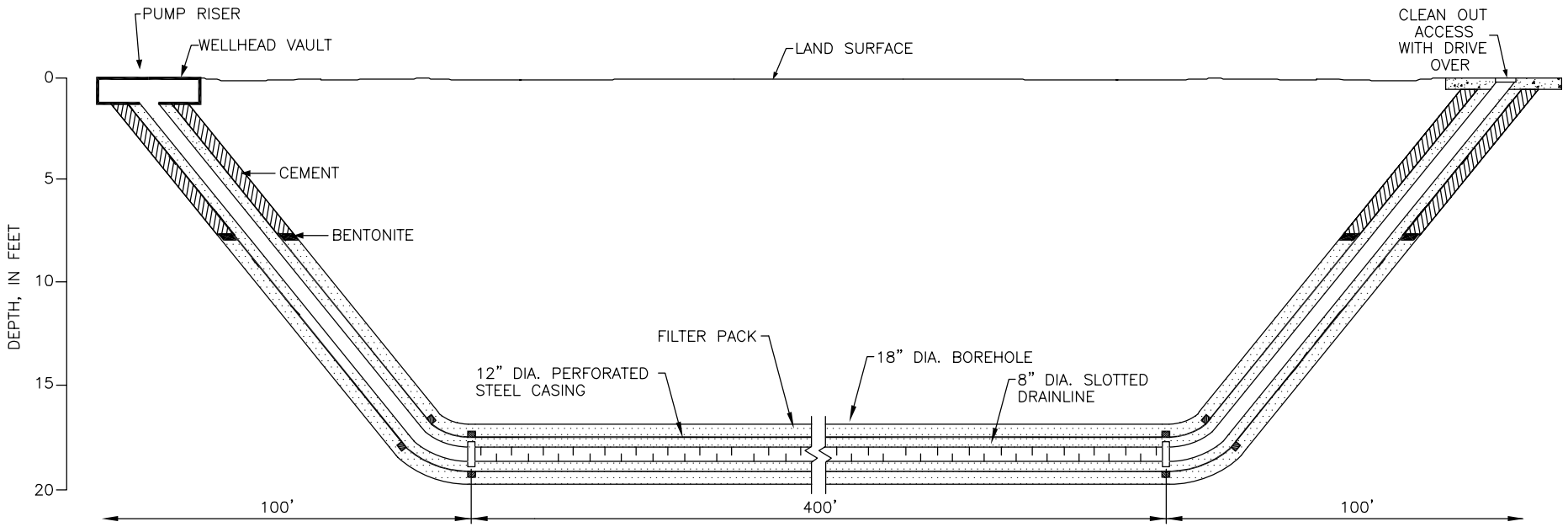
South Florida Water Management District

BOYLE

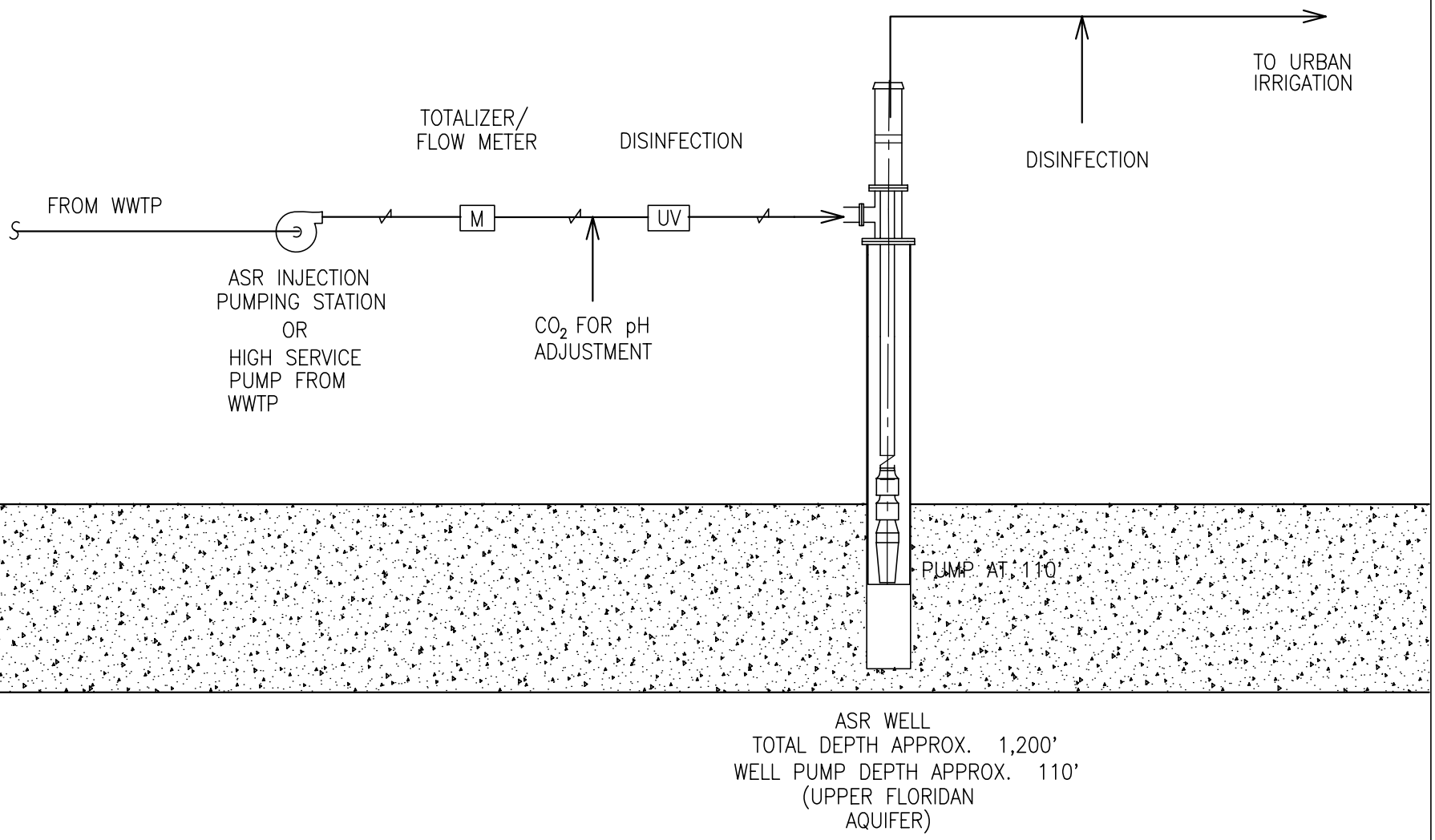
Regional Irrigation Distribution System (RIDS) Feasibility Study



Regional Irrigation Distribution System (RIDS) Feasibility Study	BOYLE		South Florida Water Management District	Typical Horizontal Well Cross-Section Installation Method A (Directional Drilled)	Figure 43



Regional Irrigation Distribution System (RIDS) Feasibility Study	BOYLE		South Florida Water Management District	Typical Horizontal Well Cross-Section Installation Method B	Figure 44



Not to Scale
For Conceptual Purposes Only

Regional Irrigation Distribution System (RIDS) Feasibility Study	BOYLE	South Florida Water Management District	Typical Reclaimed Water ASR System Process Flow Schematic	Figure 45

PIPELINE DIAMETERS AND MATERIALS

Preliminary piping arrangements for the ASR well system are shown in Figure 41. Piping and valving arrangements allow for isolation, directing of flow for recharge/injection or recovery, flow measurements, and control of recharge and recovery flow rates. Typical piping and valve sizes are presented in Figures 29 through 38.

The pipe materials anticipated for the ASR systems infrastructure will be as follows:

- For Horizontal Wells - slotted high-density polyethylene (HDPE) and Ductile Iron Pipe (DIP)
- For Injection pumping stations - DIP and polyvinyl chloride (PVC)
- For the ASR wells - DIP and PVC

For the recovery pumping stations - PVC and DIP

PUMPS AND TREATMENT EQUIPMENT DESCRIPTIONS

The typical ASR well system will include pumps, pipes, valves, meters, instrumentation, and disinfection equipment. This section includes a preliminary selection of each type of equipment, which will be confirmed during the design phase.

Pumps

For reliability, all pumping systems will be designed for firm capacity, meaning that the capacity is met with the largest pump out of service. For the surface water projects, there will be three types of pumps. As shown in Figure 39, the system includes horizontal well pumps, injection pumps, and recovery pumps. For reclaimed water projects horizontal well pumps are not necessary. In addition, the injection well pumps may not be necessary if it is determined that the WWTP's effluent pumps can be used for this purpose. For the preliminary selection of equipment for this feasibility study, the capacities needed are estimated based on the typical layout and pressure requirements from other ASR wells.

Horizontal well pumps

As shown on Figures 43 and 44 the horizontal wells will require submersible pumps to extract the filtered surface water. Table 35 presents the ASR well projects for surface water sources and the anticipated pump capacities. Pump capacities are based on potential of withdrawal benefit from the source. The depth of the sump will vary depending on subsurface geological conditions of the project site. A typical depth is about one foot below the invert of the pipe, about 20 feet below ground. The total discharge head (TDH) required is calculated based on this depth and approximately 5 feet for minor losses. Thus, the TDH for this type of well will be 25 feet. This type of pump is typically recommended for minimal turbulence and the entrance velocity should not be greater than 3.5 ft/s. The horizontal well layout allows the surface water to be filtered through the shallow soils. The pumps will operate based on a pressure transducer on the slotted high-density polyethylene (HDPE). Sample pump curves are included in Attachment J for the above list of pumps.

Table 35
Horizontal Well Pump Characteristics

No.	Project	Type of ASR Project	Benefit and Pump Capacity (MGD)	Benefit and Pump Capacity (GPM)
1	Ten Mile Canal	Surface Water	12	8,300

Injection Pumps

In some cases, the high service pumps from WWTP reclaimed water systems may be used to inject the effluent into the ASR well. Injection pumps may be necessary for others. In situations in which injection pumps are necessary, vertical turbine pumps will be used. The vertical turbine pumps will be installed in a wet well. TM No. 1 presented an estimate of the depth of each ASR well, but the final depth will be evaluated based on subsurface geological conditions at each site. The TDH for each pump is based on the anticipated pressure of injection plus some headloss. Using an estimated injection pressure of 60 psi, the TDH for these pumps will be 65 psi. The total flow for the surface water ASR systems is the same amount that was withdrawn from the horizontal wells. For the injection pump stations, multiple pumps will be used to assure reliability, using the firm capacity concept for selection. Table 36 presents the list of projects, and the injection pump capacities/characteristics.

Table 36
Injection Pump Characteristics

No.	Project	Type of ASR Project	No. of Wells	Benefit (MGD)	Pump Capacity (GPM)	No. of Pumps	Maximum Well Depth (ft)
1	Ten Mile Canal	Surface Water	17	12.0	8,300	2	1100
2	Fiesta Village / Fort Myers Beach	Reclaimed Water	12	8.1	5,600	2	1100
3	Fort Myers Central	Reclaimed Water	13	8.8	6,111	3	1100
4	Gateway	Reclaimed Water	2	1.0	694	2	1100
5	Lehigh Acres	Reclaimed Water	7	4.9	3,400	3	1100
6	Three Oaks	Reclaimed Water	5	3.3	2,300	2	1100
7	Fiesta Village	Reclaimed Water	6	3.9	2,700	2	1100
8	Fort Myers Beach	Reclaimed Water	6	4.2	2,900	3	1150
9	Fort Myers South	Reclaimed Water	12	7.8	5,400	2	1000

For the injection pumps, sample pump curves are included in Appendix B.

Recovery Pumps

Each well will have its own recovery pump system. For all the projects, the estimated flow for each well will be 0.75 MGD (521 GPM). It is anticipated that pumps for all wells will be located at approximately 110 feet and 10 feet are added for friction losses; therefore, the total TDH will be 120 feet. Table 37 presents the projects and the anticipated characteristics of the pumps. Each pump should be constructed of 316 stainless steel since it will be used to pump water from an aquifer zone, which contains background brackish water quality.

Table 37
Recovery Well Pump

No.	Project	Type of ASR Project	No. of Wells	Benefit (MGD)
1	Ten Mile Canal	Surface Water	17	12.0
2	Fiesta Village / Fort Myers Beach	Reclaimed Water	12	8.1
3	Fort Myers Central / Lehigh Acres / Gateway	Reclaimed Water	13	8.8
4	Gateway / Lehigh Acres	Reclaimed Water	2	1.0
5	Lehigh Acres	Reclaimed Water	7	4.9
6	Three Oaks	Reclaimed Water	5	3.3
7	Fiesta Village	Reclaimed Water	6	3.9
8	Fort Myers Beach	Reclaimed Water	6	4.2
9	Fort Myers South	Reclaimed Water	12	7.8

Attachment K presents pre-selected pump curves that can meet capacity requirements for the horizontal wells, injection and recovery pumps.

Treatment

Ultraviolet Disinfection (UV)

In order to meet the Primary Drinking Water Standards, UV disinfection may be necessary. The need for any treatment and disinfection will be determined based on a pilot study at each site. This type of disinfection is considered operator friendly, as it has no residual; no chemicals to store, minimal contact time, and requires a smaller footprint than other disinfection methods. The recommended UV system will be a closed vessel, medium pressure, and high intensity type system.

According to the Recommended Standards from Water Works (2003 Edition), the Policy Statement on UV Light for treatment of Public Water Supplies states that the UV system shall meet the Class A criteria under ANSI/NSF Standard 55 (See Attachment L).

Chlorine Disinfection

Chlorine disinfection may be considered, but current and emerging disinfection byproduct regulations may result in chlorine not being viable. Chlorine disinfection can be evaluated to develop site-specific information related to microbial inactivation and disinfection by-product formation similar to that done for ozone and UV. In view of the organic content of the project source water, chlorine demand and subsequent disinfection by-product formation will be high. Chloramination may be able to reduce demand and disinfection by-product formation, however significantly greater contact time will be

necessary to achieve disinfection comparable to free chlorine. Because chlorine disinfection has not been tested, it cannot be stated at this time whether or not it is a viable disinfection process. Once the appropriate evaluations have been performed, chlorine disinfection can be compared and contrasted with ozone and UV. If chlorine disinfection is able to meet water quality objectives (and this level varies depending on requirements mandated by EPA or FDEP), this process may have a competitive advantage in that disinfection could be achieved via a solid (tablet type) chemical feed/contact system. Such a system would be relatively simple to maintain and operate.

It is of importance to note that chloramination has been tested on highly colored surface water and found to be suitable for meeting the coliform standard. This procedure was evaluated for disinfection for another ASR project in South Florida that proposed to store highly colored surface water.

CONTROL REQUIREMENTS

The permit will require proper system operation and monitoring. The operation and control of the ASR well system needs to be automatically monitored for the following parameters:

- Pressure at the wellhead during injection
- Pressure at the wellhead during recovery
- Pumping water level during recovery
- Water level
- Flow rates during injection and recovery
- Conductivity during injection and recovery
- Pump motor status (on/off)
- Open/close position of each motor operated valve
- Abnormal conditions alarm (high motor temperature, high/low pressure, high/low flow)

Control panels for the well should be free standing within a NEMA 4X cabinet to include the following:

- Local/Off/Remote switch
- Lock out stop switch
- Indicator light for pump/motor status
- Indicator of monitored hydraulic parameters
- PLC and auxiliary hardware

If remote control of the ASR well is needed, a remote telemetry unit (RTU) can transmit an operator directive or provide information about the selected parameters**.**